

## **Chapter V**

# **THE MONUMENT RISES**

### **Preparations**

In October 1878, after the Joint Commission told Casey to begin work on the foundation, he immediately started construction. Many things remained to be done before he could begin. Old supply shelters and workshops that could still be used needed repair, and new ones had to be built. Several of the old facilities that had fallen into decay had been removed in 1875. Tools and machinery, particularly derricks needed to hoist the heavy stone, had to be procured and assembled. A variety of materials such as marble, granite, cement, and iron, had to be purchased by contract. Casey lost much work time advertising for proposals, awarding contracts, and waiting for delivery of supplies.

Casey and Davis had to recruit a sizeable labor force with a variety of skills. They had trouble finding skilled workers, who were much sought after in Washington. Some workers came from nearby Baltimore, which was close to the quarries. Despite this source, construction managers had to recruit workers from as far away as New England.

In early October the commission gave Casey \$3,000 to repair existing structures and to build carpenter, rigger, blacksmith, and stonecutter shops and a cement stone house. By the end of the month workers completed most of these temporary facilities. They reroofed the old one-story lapidarium, which had been used for storing the memorial stones for many years, and replastered the two small rooms at the ends of this structure for administrative purposes.<sup>1</sup>

Casey furnished the blacksmith shop with three forges and a supply of tools and other necessary materials. A new road connecting the monument grounds to 14th Street helped move supplies. Although the lumber for the stonecutter shed was delivered early, it was not built until the following year because work on the shaft would not begin for a long time. When completed, the shed measured 76 by 36 feet.<sup>2</sup>

Casey anticipated that work on the shaft would require an even larger labor force. In January 1880 he requested more stonecutter sheds, railroad tracks about the monument grounds to help in receiving and hand-

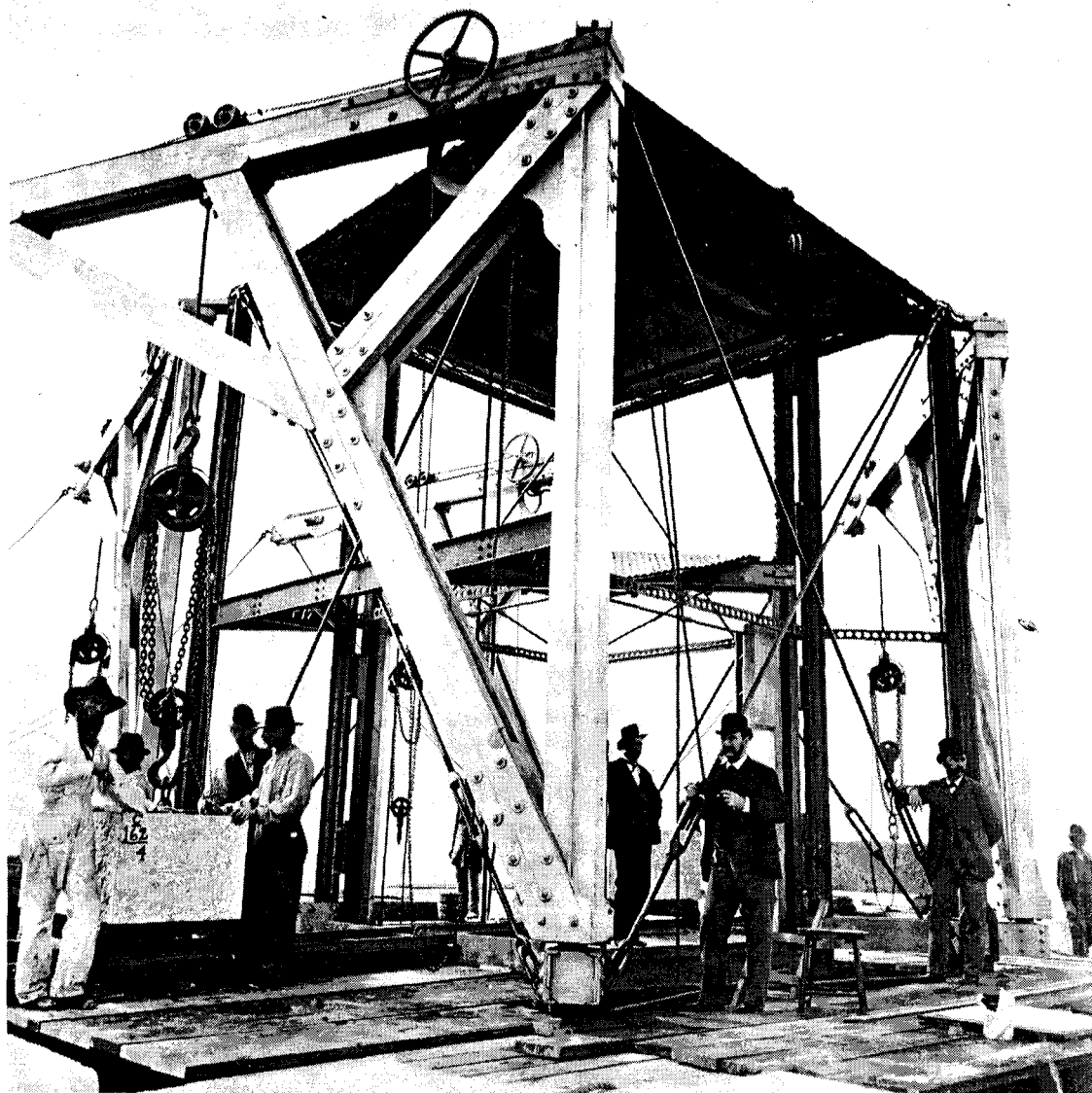
ling heavy supplies, a safety net at the top of the shaft to prevent accidents, and a latrine for the workmen. He proposed using the western end of the cement house as an additional blacksmith shop. Although work on the obelisk was several months away, it was typical of Casey to plan well in advance. The commission allowed Casey to build these and other facilities.<sup>3</sup>

To improve safety conditions around the base of the foundation, Casey ordered all debris from the old construction work removed from the top of the shaft. Workmen placed new blocks, faces, and supports in position to permit access to the top and installed new wooden doors at the base to prevent entry by vandals and unauthorized people. Accumulated debris in the well at the center of the foundation was also removed to 23 feet. To measure any settlement of the shaft, a bench mark was cut at the top of each of the corners of the fourth step of the foundation, counting from the bottom. Each bench mark was compared and made to correspond exactly in height.<sup>4</sup>

Although Casey left a wealth of detail about the methods and machinery he used, little has been published on the subject. Work on the monument required basically two different types of operations—digging around and beneath the foundation and lifting very heavy loads to high altitudes and setting them into place on the shaft. The equipment used to strengthen the foundation was generally common for its day, but the work was burdensome and delicate. The workmen had to remove huge quantities of earth from underneath and around the foundation without disturbing the earth supporting it. Casey used three basic types of machines. Derricks, concrete mixers, and hoisting equipment removed and carried earth to the surface and mixed and carried concrete to the bottom to form the foundation. By the end of 1878, four derricks and two concrete mixers run by steam engines were positioned around the base of the shaft. About 580 feet of 4-inch vitrified pipes drained the water from the concrete mixers. Casey also ordered cars, sling bodies, and tubs built to remove the earth from cuts and transport the concrete to fill the excavations. These cars ran on a network of iron rails.<sup>5</sup>

In September 1878 Casey wrote to a correspondent who asked how he would build the shaft: "It is impossible now to furnish drawings showing plan...but I would say in general terms that machinery will be required capable of raising weights of 10,000 pounds to the height of 500 feet and the engine should be so constructed that its power could be used for other purposes than hoisting." He concluded that it would be desirable to use an engine that could not only hoist extremely heavy stones and workmen to unusual heights, but that could also lift a passenger elevator in the completed monument.<sup>6</sup> Casey was seeking equipment that could serve two purposes: first as a tool in the construction of the monument, and later as a permanent facility to serve visitors.

Casey's plan required a large quantity of iron to form a skeletal



**Workmen hoist a piece of marble with the help of a stone-setting crane atop the monument.** *Library of Congress (photograph USZ62-15293).*

framework rising almost the full height of the monument. A temporary platform elevator run by a permanently installed passenger elevator engine would lift the stones and other supplies inside the shaft. Four wooden cranes swung from Phoenix iron columns that supported a permanent stairway would set the stones.<sup>7</sup> Because Casey had planned for a permanent facility, it required the commission's approval, which was quickly granted.<sup>8</sup>

The plan required a pit 16.5 feet long, 10 feet wide, and 7.83 feet deep in the floor of the obelisk. A winding drum, inserted in the pit, would hold the hoisting ropes. The Phoenix columns of the elevator and stairway also went into the pit. The workers completed it the end of 1879.<sup>9</sup>

Workmen constructed a scaffold or platform inside the top of the shaft, where they placed a derrick to receive the stone and remove the deteriorated courses of marble and other debris.<sup>10</sup> This was done without the elevator, which had yet to be constructed.

Casey knew that progress depended upon the timely delivery of supplies. Unfortunately, no matter how carefully he selected contractors or how adamantly he insisted on the timely arrival and acceptable condition of supplies, items were frequently late. Those that did arrive on time were sometimes inadequate. This was especially true of marble, an item that, if not quarried or dressed properly, could mar the beauty of a structure or even weaken it. Late deliveries were not always the fault of the contractors. Sometimes strikes, weather, transportation, or other unforeseen events slowed shipments. Regardless of the reason, Casey showed little sympathy for contractors who did not meet their obligations.

The company that provided Portland cement caused costly delays. Casey had selected J.B. White and Brothers, a New York firm, because he considered their Portland cement the strongest and best known in Europe and America. He was deeply disappointed when, for one reason or another, the contractor repeatedly failed to make his deliveries. With no cement to make concrete, Casey was forced to lay off workers. This strained his plans and projections. After several of these costly delays, Captain Davis wrote the contractor that "past and prospective failure to keep up this supply make your execution of the contract anything but satisfactory."<sup>11</sup>

Contracts for purchasing marble presented the most serious problems. Casey took great pains to see that the marble he bought matched that on the unfinished obelisk and that it was the most durable of its kind. His specifications to prospective bidders were clear:

The marble must be white, strong, sound, and free from flint, shakes, powder cracks, or seams, and must in texture and color so conform to the marble now built in the monument as not to present any marked or striking contrast in color, lustre, or shade, when set in the wall.

The stock must also be free from impurities that would so discolor the stone as to deface the general appearance of the work to a greater extent than that now shown in the portion of the monument erected. . . . each bid must be accompanied by a slab of the marble, sawed or fine cut perpendicular to the quarry bed. . . . These cubes when subjected to a crushing pressure between steel plates with cushions of wood, must sustain a pressure of at least 8000 lbs. to the square inch.

If the bidder has a chemical analysis of his stock he will submit an authenticated copy of the same with his proposal.<sup>12</sup>

At the end of 1878 Casey tested several specimens of marble from the unfinished structure and from the Baltimore County, Maryland, quarries where the old marble had been obtained for strength and durability. The two-inch cubes were crushed in the Corps' New York office by a hydrostatic press. The 12 specimens from the top of the shaft compared favorably with crystal marble specimens from the quarries.<sup>13</sup>

On 19 July 1879, Casey invited proposals for bids on rough marble.

To make an intelligent selection of contractors, Casey ordered Davis to inspect the quarries of four bidders in New England, New York, and Baltimore to determine whether their facilities could produce the desired quantity of marble. Davis reported that John A. Briggs' quarry in Sheffield, Massachusetts, could supply the amount needed. Moreover, Davis felt that this marble's color and texture would not significantly contrast with the marble already in place. Based on Davis' conclusions, Briggs received a contract for 12,000 cubic feet of rough marble.<sup>14</sup>

Before long Casey realized his mistake in selecting Briggs. The company repeatedly failed to make timely deliveries, and when the marble came, the dimensions were incorrect and the stone defective in color. Casey and his assistant rejected many of these pieces, but their careful scrutiny caused delays.<sup>15</sup> After acquiring enough marble to cover an area on the monument six feet high, Casey annulled the contract in July 1880. During the same month, he signed a contract with Hugh Sisson of Baltimore for 40,000 cubic feet of white marble from his quarry in Beaver Dam in Baltimore County, the same general area from which the marble for the unfinished shaft had come.<sup>16</sup>

Although a much more reliable contractor than Briggs, Sisson also had his faults. Casey relied heavily on Sisson's continuing ability to quarry marble, even during moderate winter weather, because of his excellent equipment and facilities. Still there were delays in delivery, with the consequent lay-off of marble cutters and laborers. These delays became so serious that at one point the Joint Committee felt compelled to annul the contract. Casey was the first to admit that Sisson had violated his contract, but he was convinced that the contractor was doing the best he could to produce the necessary quantity of marble. Casey recommended to the commission that the contract not be annulled, pointing out that it would be difficult to get a more reliable contractor unless the contract called for the delivery of all the marble needed to complete the monument at one time. Because annual congressional appropriations were limited, such a stipulation would be impossible.<sup>17</sup>

Thanks to Casey, Sisson continued to supply marble through succeeding contracts signed in May 1881 and May 1882. However, in April 1883 the Joint Commission considered a contract with the Lee Marble Company, a New York firm with quarries in Lee, Massachusetts. This company's price of \$1.29 a cubic foot outbid Sisson's price of \$1.50. Although Casey had some reservations as to the company's ability to quarry marble during winter months, the quality of the marble and the fairness of the price impressed him. Based on Casey's recommendation, the commission took on the new contract.

Casey soon found he had made another mistake. After Casey granted the company four extensions for the initial delivery and Davis visited the quarry to determine its ability to fulfill its agreement, the Lee

Marble Company requested that its contract be annulled.<sup>18</sup> The commission agreed and immediately signed a contract with its old supplier, Hugh Sisson. Rough marble soon began to arrive at the monument site, but Casey had lost three months of work.<sup>19</sup>

Working with marble presented some unique problems. Because the stone could be easily damaged or defaced while being quarried, it could only be removed carefully and at considerable expense. Slight discolorations and cracks in pieces of marble, however minor, could easily affect the beauty of the finished structure. Careful inspections at the site delayed the construction of the monument despite Casey's planning.

Contracts for building materials like granite and iron did not present such serious problems, although Casey was equally adamant in his demands that these items be of the highest quality. His specifications to bidders for rough granite were as precise as those for marble:

the granite must be strong, sound, and [free] from shakes, powder cracks or seams, but it is not required that it should be free from stains, unless these are due to some foreign impurities that will cause the disintegration of the stone. . . . each bid must be accompanied by three (3) cubes dressed accurately. . . . These cubes when subjected to a crushing pressure between steel plates with cushions of wood, must sustain a pressure of at least 16,000 lbs. per square inch. . . . Bidders must be able to show to the contracting agent of the United States, that they have quarries and sufficient 'plant' in place, in such working order as to be able to comply with these specifications and to furnish the stock as desired.<sup>20</sup>

All the granite came from several Maine suppliers. It arrived at the monument site with almost no difficulty. A durable stone, the granite was not subject to the same scrutiny as the marble because it was used for the interior of the shaft. There was always an adequate supply of granite, even during the winter, so the stonecutters could even work through the winter.<sup>21</sup>

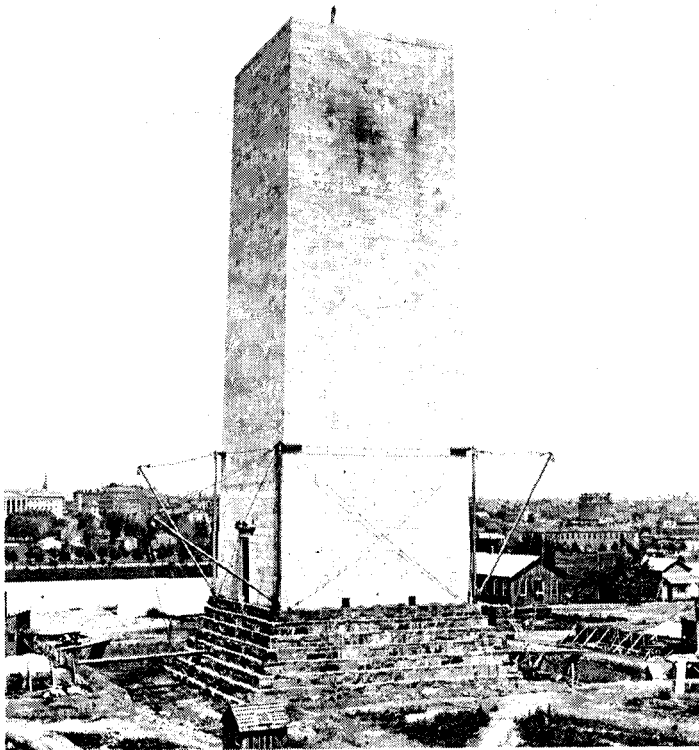
Iron, another major item, also presented few contract problems. In late 1879, while preparing for work on the shaft, the commission contracted for the delivery of enough iron to construct the stairway and elevator shaft to 250 feet.<sup>22</sup>

When Casey took charge of the monument's construction in July 1878, he supervised not only his assistant Captain Davis, one clerk, and one draftsman, but a labor force of six riggers, one mason, three stonecutters, two drillers, two carpenters, 26 laborers, one night watchman, and one water boy. With the exception of Davis, this crew accounted for total wages of \$504.79, modest even for those days.<sup>23</sup> Casey used this force largely to clean up the area, help form plans, and in general prepare for the construction. More men would be needed once work on the foundation and the obelisk began.

Casey conducted his own recruiting. Experience taught him that it took advanced planning to recruit skilled and experienced workers of the kind needed for the monument. In September 1878 he wrote to the chief engineer of the Sutro Tunnel in Virginia City, Nevada, that to underpin the monument he needed skilled workmen accustomed to subterranean excavations and the accompanying great pressures. "Men," he said, "whom I would be willing to trust for this work are not to be found here." But, he added, "it has occurred to me I might find them among the mines in Nevada who have had much experience in tunneling through enormous clay deposits which are so extensive all through the Comstock." Casey wanted one or two men with this experience and skill to supervise others, "men who do not mind the mud, darkness, and danger of such working."<sup>24</sup>

Whether anything came of this request is uncertain, but it does indicate how important Casey considered this work. That same month Casey visited Baltimore where workmen were tunneling and excavating for a water supply system. He found a few skillful men there to oversee excavations on the monument's foundation.<sup>25</sup>

By the beginning of 1879, when work on the foundation was well underway, the labor force had more than doubled and wages had reached \$2,785.61. The addition of several skilled workers was responsible for some of this increase in the payroll. Seven months later the work force reached 175 men, most of whom were working on the foundation.<sup>26</sup>



The monument in August of 1879 with work on the foundation in progress. The pond behind the monument is Babcock Lake, which was later drained and filled to protect the foundation's stability. *Library of Congress (photograph USZ62-10828).*

As work on the shaft was ready to begin in 1880, Casey began to calculate how many stonecutters he would need in relation to the amount of marble and granite that would be delivered during the first year. Assuming that one stonecutter could prepare six cubic feet of stone in one day, Casey estimated it would require 120 stonecutters to dress stone in 4.5 months. If he employed 120 stonecutters, he would need 5,000 cubic feet each of marble and granite each month. He would also need additional sheds, blacksmith forges, and other related facilities to accommodate such a large work force.<sup>27</sup>

Most of the labor force consisted of marble and granite stonecutters. In July 1880 there were only 40 cutters on the payroll, but by the end of the following month there were 62. This number increased steadily until it passed 100.<sup>28</sup>

While Casey recruited stonecutters, he was besieged by applicants who were sponsored by congressmen. Because the quantity of stone was below expected levels and adequate work and housing facilities were not available, Casey had to turn away many of them. Davis wrote to one congressman from Maine that "if you send a list of names of men whom you have recommended, they will be entered on our list and sent for as rapidly as vacancies occur for them and they can be given work."<sup>30</sup>

At the peak of construction, the work force reached approximately 170. This number varied as the situation changed. The crew consisted of marble and granite cutters, stone setters or masons, blacksmiths, carpenters, riggers, engine drivers, machinists, firemen, water and tool boys, and ordinary laborers. Next to stonecutters, laborers comprised the largest group. Casey spent about \$8,500 a month on wages for this sizeable force.<sup>30</sup>

Casey hired marble cutters on the assumption that the marble would be delivered on time and in the desired quantities. Because this was often not the case, marble cutters were either furloughed or worked only part time. This situation led the marble cutters to petition the commission to reduce their 10-hour day to eight. Casey agreed because he felt it would not affect construction. In arguing the cutter's case before the Building Committee, he pointed out that there would be no increased cost to the United States because the cutters' work was done entirely by the "piece or so much per square foot of cutting accomplished." Casey had one reservation, however—that the arrangement might cause friction with those workers who still had to work 10 hours a day. The idea was accepted by the Building Committee with the stipulation that if the amount of marble delivered increased or if ill feelings developed among the labor force, Casey would have to return to the 10-hour day. It is not known how long this plan remained in effect, but it was to be only a temporary measure until marble deliveries picked up.<sup>31</sup>

Casey did not have these problems with the granite cutters. Because

deliveries were usually substantial, the crew constantly worked fulltime. A comparison of wages during the second phase of construction with wages paid for the same set of skills during the first stage (1848 and 1854) reveals only a modest change. Those who benefited during these years were the stonecutters, whose growing national union had made large inroads in the construction industry. In 1880, both marble and granite stonecutters and stonemasons received \$2.50 a day. By 1884 marble cutters received \$3.50 a day. Compared to wages earned in 1851 this was a modest increase, but compared to other skills, it was substantial. The ordinary laborer did not fare as well as the skilled worker. In 1879 laborers were classified into three categories: a first class laborer earned \$1.75 a day; a second class laborer \$1.50; and a third class laborer \$1.25. Compared with the \$1.00 a day earned by laborers three decades earlier, wages had not gone up perceptibly.<sup>32</sup>

Casey demonstrated a sincere concern for the welfare of his workers, recognizing the dangers and tediousness of the job. Before work started on the shaft, he built a safety net around the four sides of the top of the obelisk, which saved several lives. While Casey was in charge of the monument work, no one died because of an accident.<sup>33</sup>

Casey also appreciated excellent work. In 1884 he recommended to the Building Committee that his overseer, P.H. McLaughlin, receive an increase of \$25 in his monthly wage. In November 1884, as the obelisk approached completion, Casey extended his generosity to the men working at the top of the structure by offering them coffee in "moderate quantities" to overcome the bitter cold.<sup>34</sup>

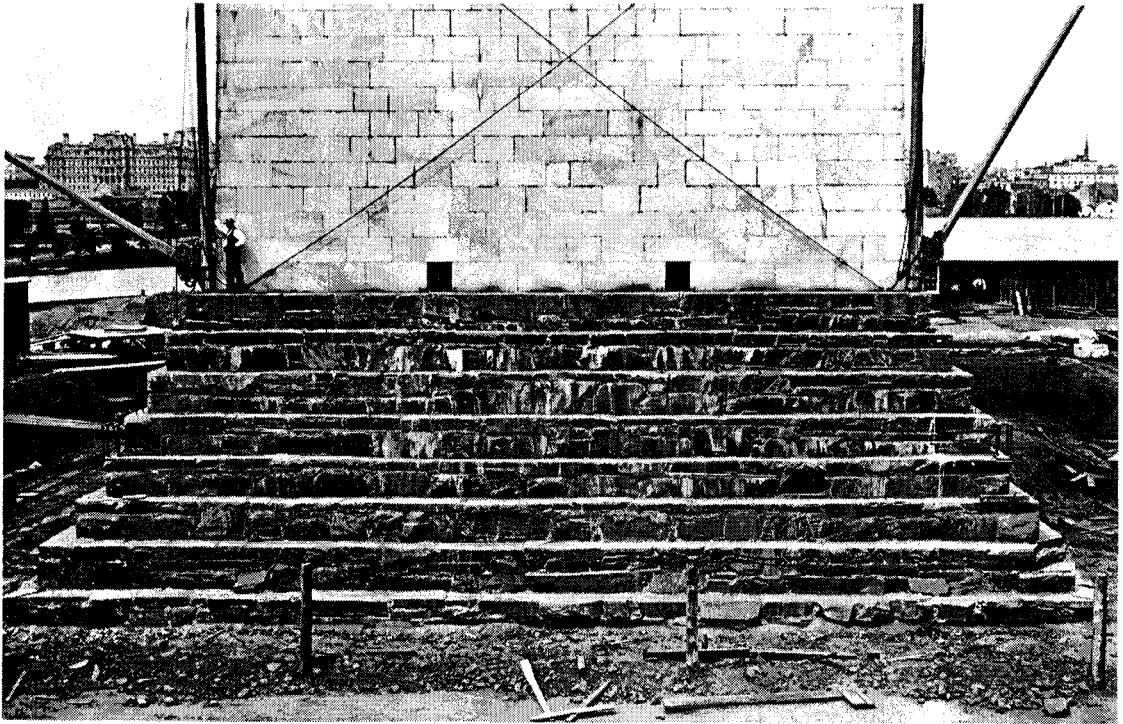
Casey had little tolerance for work stoppages. Striking longshoremen in New York prevented the delivery of Portland cement for the foundation, which deeply annoyed him. Later when the monument was nearly complete, strikes were fairly common at the site, particularly among stonecutters, who had a strong union. In September 1884, during one of these strikes, Davis frantically telegraphed Casey, who was in New Hampshire at the time:

Another strike: Man discharged for carelessly spoiling stone; he denies carelessness asserting blind seam. I investigated minutely. Satisfied cutter was at fault and declined to pay him for four days work done. All hands quit until man was paid. I replied that you would decide on returning to city regarding equity of claim of man discharged. They still declined to resume until man was paid. Gen. Newton approves my course but prefers to take no action in your absence. Suggests that I telegraph facts to you. He would close the sheds rather than submit to bull dozing. Value of stone spoiled seventy five dollars....<sup>35</sup>

## **Underpinning the Foundation**

Freezing weather delayed excavation work, but by the end of January 1879, Casey had enough facilities, machinery, tools, supplies, and

workmen on hand to begin underpinning the foundation. The original foundation, constructed in 1848, consisted of a rubble masonry of blue gneiss laid in lime mortar. The foundation measured 80 feet at the base on each of its four sides, 58.5 feet at the top, and 23.5 feet high. The footings were 7.67 feet below the surface. The foundation, which rested on a loam composed of equal parts of sand and clay, weighed about 32,000 long tons. Some small boulders were interspersed throughout the earth. The permanent water level was 12.5 feet below the footings.<sup>36</sup>

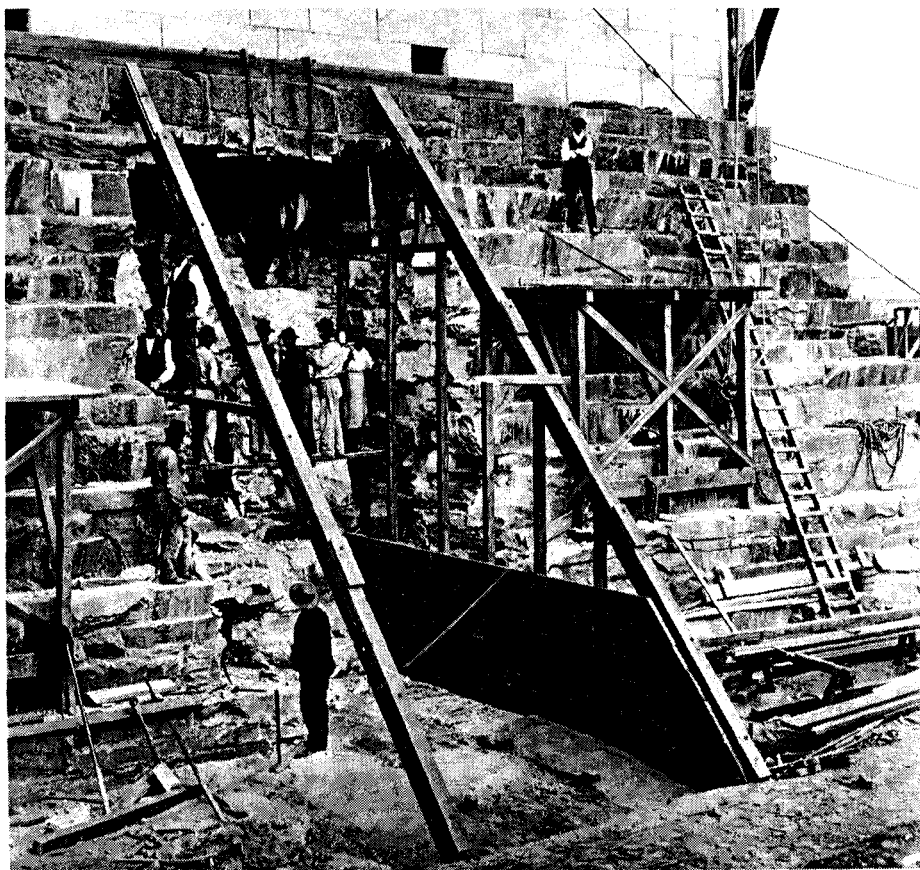


Excavation in preparation for pouring concrete beneath the old foundation. *Library of Congress (photograph USZ62-30613).*

Casey developed a two-step plan to strengthen the foundation. Both stages called for widening and deepening the existing foundation to distribute the weight of the monument over a larger area. During the first stage, workmen would place a mass of concrete 13.5 feet thick below the foundation, which would extend 23 feet outward beyond its edge. The second step involved removing a portion of the old foundation from beneath the shaft and placing buttresses in each of the four corners and one in the center of each side. These buttresses were to be extended to make contact with the new slab.<sup>37</sup> The first step removed 10,334 cubic yards, or 70 percent of the earth, under the old foundation and replaced it with a huge concrete slab. This slab extended the foundation on each of its four sides to 126.5 feet, which enlarged the area covered from the original 6,400 square feet to nearly 16,000 square feet. The whole mass contained 7,003 cubic yards of concrete, a mixture consisting of one part Portland cement, two

parts sand, three parts pebbles, and four parts broken stone. After this concrete set for 7.5 months, it would have a crushing strength of 155 tons per square foot.<sup>38</sup>

The first phase of construction, begun on 10 February 1879, and completed without any serious problems on November 1, would have been completed sooner except for delays in the shipment of Portland cement. The second phase, the construction of the buttresses, began in September 1879. Immediately after work started, Casey told the Building Committee that he wanted to modify this part of his original plan. He had proposed cross walls, or a leg of masonry concrete, under the center of the foundation, but now he suggested that the earth remain undisturbed “as there could be no lateral displacement of it, and it would yield but an insignificant degree under its present load.” He also proposed building a “continuing” concrete buttress to support the foundation and unite the old and the new foundation instead of putting three buttresses on each side as he originally suggested. The new idea was quickly approved by the committee and adopted by the commission.<sup>39</sup>

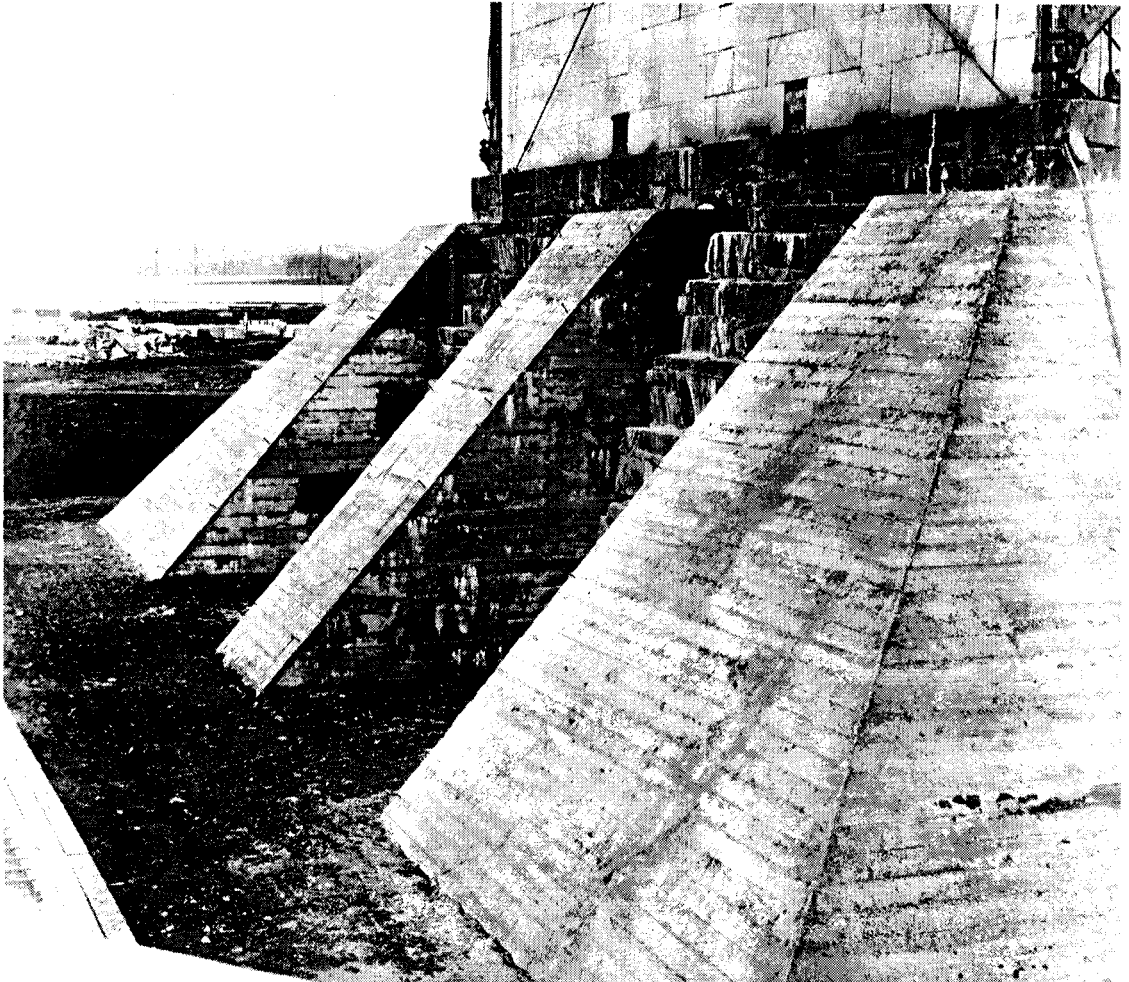


Sections of the old foundation are removed to make way for construction of concrete buttresses, October 1879. *Library of Congress (photograph USZ62-26189).*

On 28 May 1880, the crew completed the second stage of underpinning. The concrete that went into the buttresses consisted of one part Portland cement, one and one-half parts sand, two and one-quarter parts

pebbles, and three parts broken stone. Casey wanted the concrete for the buttresses to be much stronger than the concrete used for the slab. Workmen excavated approximately 348 cubic yards from the old foundation and used about 520 cubic yards of cement for the buttresses.<sup>40</sup>

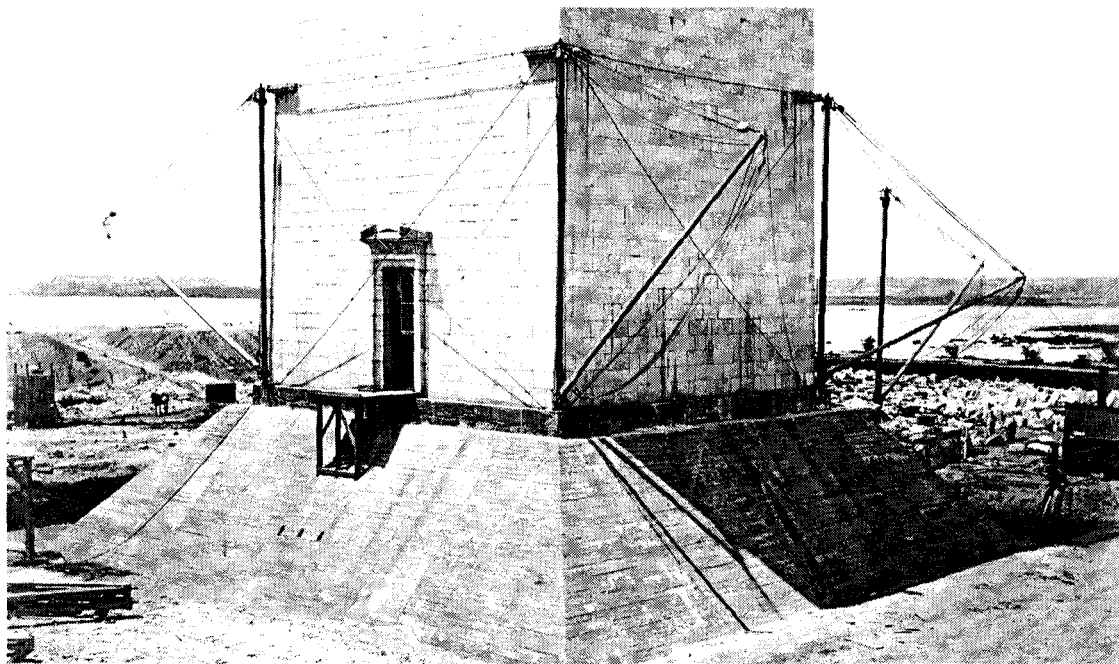
On June 7 Casey's men began covering the new foundation with the earth that had been excavated. In five weeks they completed the embankment that provided a terrace all around the shaft. The embankment was 30



**Buttresses on southeast side of the monument, January 1880. Library of Congress (photograph USZ62-30612).**

feet wide and 17 feet above the general level of the site. In December Casey recommended to the Building Committee that they extend the terrace another 30 feet by using the old blue stone that had been dug up during the underpinning. He believed that because this refuse was heavier than ordinary earth, it would lend greater support to the foundation. The committee approved his proposal, and contract workers completed the job the following year. When enlarged, the embankment was 175 feet on each side “on the edge of the crest” and 220 feet at the foot of the slopes. The embankment contained 11,810 cubic yards of dirt and gneiss rock.<sup>41</sup> With the embankment finished, work on the foundation was essentially completed.

Casey's plan for strengthening and underpinning the foundation was not new to engineers of his day. What was new was his ability to accomplish such a delicate operation on such a large scale. Although some criticized his plan long after it was executed, particularly pessimists who claimed that the new foundation would never support the completed monument, it received world-wide acclaim.



**New foundation completed in May 1880. Library of Congress (photograph USZ62-15294).**

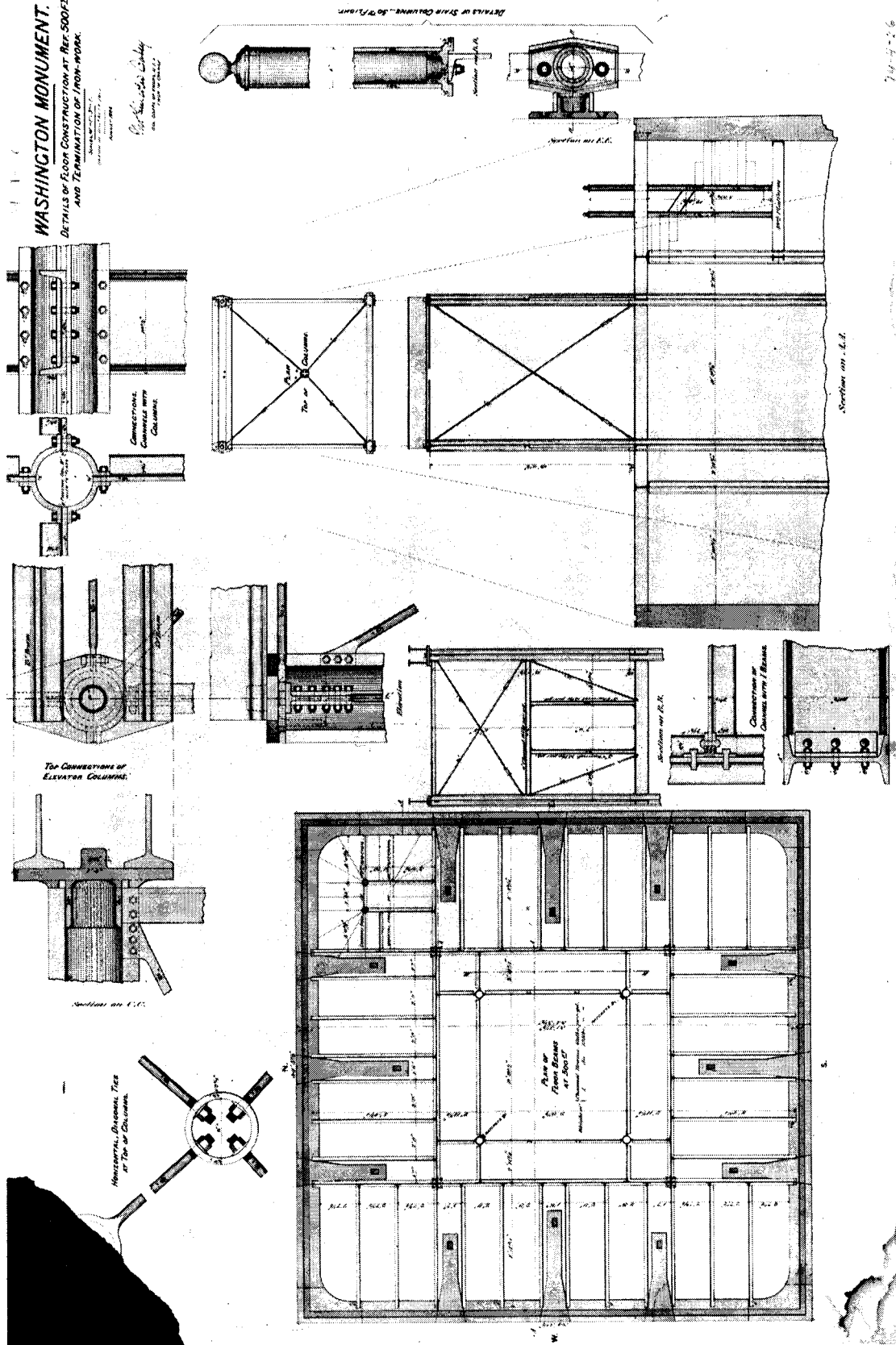
Casey described his work on the foundation at the monument's dedication in 1885:

As completed, the new foundation covers two and a half times as much area and extends thirteen and a half feet deeper than the old one. Indeed, the bottom of the new work is only two feet above the level of high tides in the Potomac, while the water which permeates the earth of the monument lot, stands six inches above this bottom. The foundation now rests upon a bed of fine sand some two feet in thickness, and this sand stratum rests upon a bed of boulders and gravel. Borings have been made in this gravel deposit for a depth of over 18 feet without passing through it, and so uniform is the character of the material upon which the foundation rests that the settlements of several corners of the shaft have differed from each other by only the smallest subdivision of an inch. The pressures on the earth beneath the foundation are nowhere greater than the experience of years have shown this earth to be able to sustain, while the strength of the masonry in the foundation itself is largely in excess of the strains brought upon it. The stability of this base is assured against all natural causes except earthquakes or the washing out of the sand bed beneath the foundation.<sup>42</sup>

**WASHINGTON MONUMENT.**  
**DETAILS OF FLOOR CONSTRUCTION AT REF. 50071**  
**AND TERMINATION OF IRON-WORK.**

Approved: \_\_\_\_\_  
 Date: \_\_\_\_\_

*Wm. H. H. H. H.*  
 on design and construction  
 of the monument.



Diagrams of floor construction at the top of the monument and the ironwork for stairs and floor. National Archives (Record Group 79, file 74.4-26).

The underpinning had been finished without the slightest crack or damage to any part of the completed shaft. What may have pleased Congress even more was that the new foundation cost \$94,474, well within Casey's estimate and the two appropriations voted by Congress.<sup>43</sup>

## The Obelisk

After completing the new foundation, Casey and his assistants reorganized the work force and rearranged the machinery and plant to begin work on raising the obelisk to 555 feet. While work continued on the foundation, workers placed derricks atop the shaft. Meanwhile 380 feet of stone sheds were added to the 76 feet already built. A railroad network of 2,600 feet was laid and equipped with turntables and cars to help move heavy supplies to and from the main railroad line and the monument site.<sup>44</sup>

Two basic materials, stone (marble and granite) and iron, comprised the obelisk. Casey used iron to build the elevator and skeletal framework. He started construction on both early because they had to be installed before work could begin on raising the shaft.

In June 1879 Casey presented his construction plan to the commission. Unfortunately, he had not found in the Society's old records any indication of the technique used to hoist stones to the top of the obelisk. It was obvious from existing conditions that the plan had been to construct a stairway in the well of the shaft, but how was not clear. The positions of the donated memorial stones convinced Casey that the original builders had intended for the east and west faces of the shaft to sustain the landings of the staircase, while the north and south faces would bear the staircases and steps. Casey decided to follow this arrangement for the staircase.

The steps and landings, which were to be made of wrought and cast iron, measured 56 inches wide. The sum of the rise and tread of the steps was a little more than 17.75 inches. The well of the stairway was to be 15.75 feet on each side. The I beams and channel bars that formed the platforms and stairway carriages would be strongly fastened into wrought iron Phoenix columns set on each corner of the well. All the coverings and ceilings of the platforms, treads, and rises of the steps were to be cast iron.<sup>45</sup>

Casey planned to set smaller wrought iron Phoenix columns within the staircase well. These columns were then to be connected by bars and braces to the large Phoenix columns that supported the staircase and to the I beams of the landings. All eight Phoenix columns and the I beams of the platforms were to be extended above the top of the obelisk as work progressed. This would establish points of support for the hoisting machinery of the elevator platform and supply the vertical support for the revolving arms of derricks used in setting the masonry upon the shaft.

Casey proposed to run the elevator with an engine powerful enough to raise the heaviest load 50 feet per minute. He estimated that he needed near-

ly 550 tons of iron to build the staircase and elevator shaft. During the first year he needed enough iron to raise the monument to 250 feet. The Joint Commission approved Casey's plan the same month that he submitted it.<sup>46</sup>

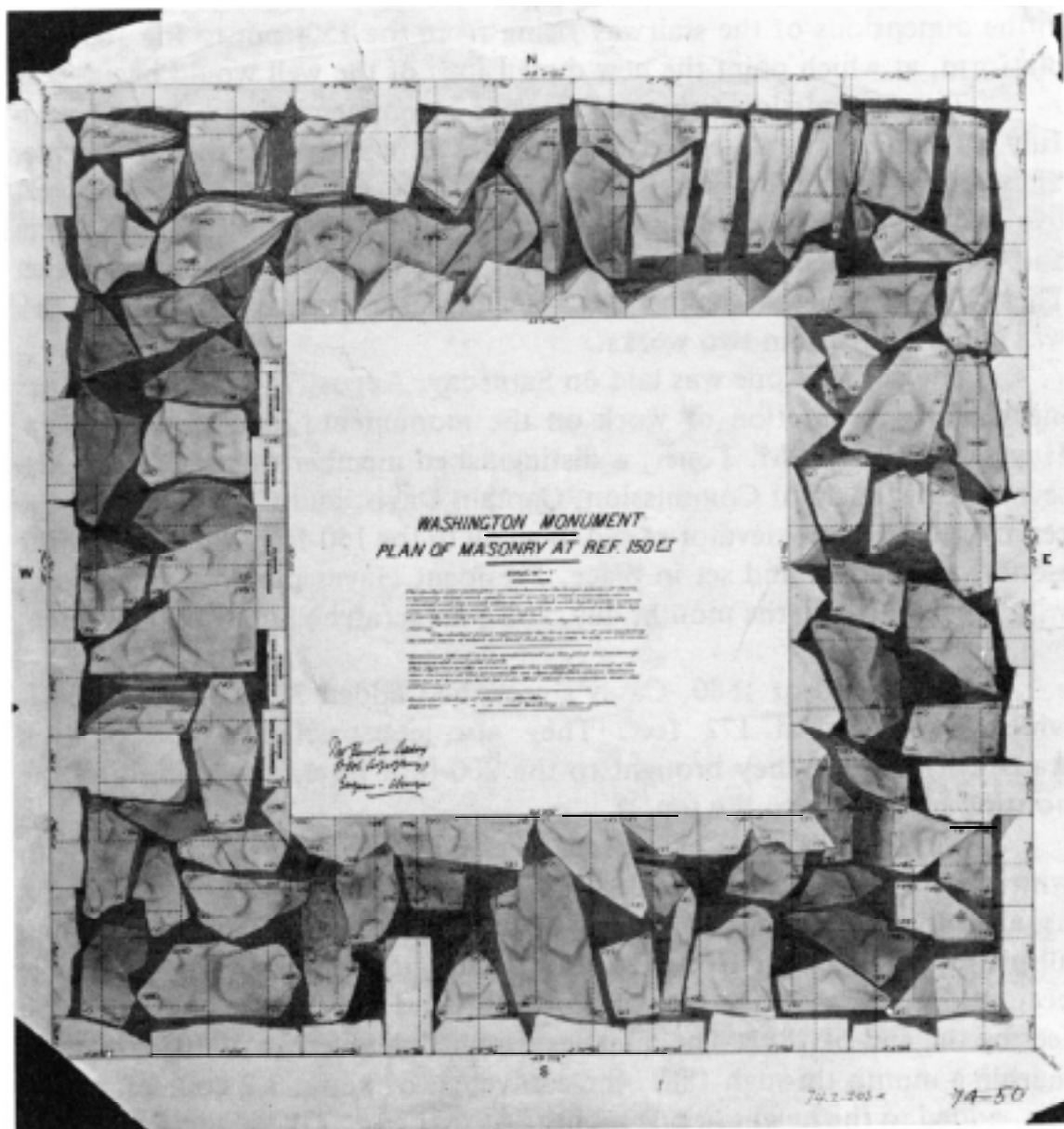
Casey described his idea of an elevator car to prospective contractors. The car would operate within the four small Phoenix columns that formed the elevator shaft, which enclosed a square space just over 9.75 feet on each side. Excluding the car, the greatest weight the elevator was expected to carry was six tons.

Two hoisting ropes were to pull the car, made of the best annealed iron wire or steel, each would have a tensile strength sufficient to raise the heaviest load. The winding drum would be located on the floor of the obelisk's well. Shafting and a train of cog wheels would transmit the power. The engine and boiler to produce the power would be outside the west face of the monument and level with the top of the foundation. The winding drum would hold 500 feet of rope.<sup>47</sup>

With his plan approved by the commission, Casey moved quickly. In August he signed a contract with the Phoenix Iron Company of Trenton, New Jersey, to supply a 250-foot-tall iron framework. In November he issued a contract to Otis Brothers and Company of New York City to produce the elevator and its hoisting machinery.<sup>48</sup> That same month Casey's men completed the pit to house the winding drum. It measured 16.5 feet long, 10 feet wide, and 7.82 feet deep. The walls, cast in one piece, were made of the same concrete mixture used in making the foundation buttresses. Workers also placed the four granite blocks that would encase the foot plates of the Phoenix columns of the staircase. The crew excavated the holes in the interior walls to receive the I beams and channel bars, with mortice holes ranging from 8 to 24 inches in depth.<sup>49</sup>

After the mortice holes were completed, the Phoenix Iron Company immediately began setting the iron framework into place. By the end of January 1880, the framework reached 40 feet, and by the middle of March it rose to 180 feet. Otis Brothers began work on the elevator on 1 April and finished by 12 July. Casey immediately tested and accepted the elevator, winding drum, engine, and boiler. At the same time, Casey's men prepared the equipment to lift and set the large blocks of stone on top of the obelisk. They finished by mid-July.<sup>50</sup>

When Casey took charge of construction, the monument was already 156 feet high. The top courses installed during the period of Know-Nothing control had been put up with the "refuse" pieces of marble scattered about the site. The headers of several pieces of marble in these courses were too small to be used in Casey's plan. Also, the marble facing at the top had been forced slightly outward for some distance downward, probably by the expansion of frozen water that had gotten in between the backing and facing. Casey recommended that 6 feet of marble be removed from the top and that



After removing six feet of damaged marble, Casey reinforced the deteriorated mortar between the stones beneath. The dark areas in this cross section view from the top represent cavities between the stones, cleared of old mortar and refilled with hydraulic cement. The diagram shows the blue gneiss stones in the interior, the marble face of the monument, and the memorial stones in the interior shaft. *National Archives (Record Group 79, file 74.2-203).*

the wall be reset with new marble, thereby giving it the diminished thickness his plan demanded.

He strongly believed that these actions would have several advantages. For one thing, after eliminating 6 feet he could secure a stronger masonry by reaching a section of mortar less disintegrated from the effects of the frost. For another, he could secure a rectangular figure to begin work that was less distorted from a square than the edges of the courses above 150 feet. Finally, Casey would be able to begin the sloping masonry of the inside well at the bottom of a flight of stairs. This would secure a uniform increase

in the dimensions of the stairway rising from the 150-foot to the 160-foot platform, at which point the new dimensions of the well would begin.<sup>51</sup>

The commission approved Casey's recommendations, and by mid-July his men began to remove three courses (6 feet high) of the old marble. They then prepared the surface of the 150-foot level to receive the new stone by removing the spalls and disintegrated mortar that lay between the granite and marble pieces and filling the voids with hydraulic cement concrete. These fillings varied in depth from a few inches to several feet.<sup>52</sup> The work was completed within two weeks.

The corner stone was laid on Saturday, August 7, amid fanfare that marked the resumption of work on the monument. President and Mrs. Hayes, Dr. Joseph M. Toner, a distinguished member of the Society, the secretary of the Joint Commission, Captain Davis, and Casey attended the ceremony. The new elevator raised them all to the 150-foot level. Before the stone was lowered and set in place, President Hayes placed a small coin, with his initials and the month, day, and year scratched in it, in the cement bed.<sup>53</sup>

By the end of 1880, Casey's crew had added 22 feet to the shaft, which now reached 172 feet. They also constructed a 20-foot iron framework, which they brought to the 200-foot level, and shifted all the hoisting machinery to the top.<sup>54</sup>

Work on the shaft progressed as rapidly as possible. The speed with which the obelisk rose depended largely on the arrival of materials. As usual, shipping delays, particularly of marble, frustrated Casey, who had all his moves planned. However disappointing these slowdowns may have been at times, Casey had enough stone on hand to raise the obelisk to 250 feet by the end of 1881. The quarries supplied an average of 103 blocks of marble a month through 1881, the equivalent of about 3.2 courses, or 6.4 feet, added to the height in one month. At that rate, 77 feet could be added to the height of the shaft each year. Therefore Casey estimated it would take three more seasons to complete the monument.<sup>55</sup>

At the end of each November, Casey gave the commission a list of his expenditures. He always indicated how far the balance would go towards the monument and how much more he needed to complete it. He stressed that if Congress did not pass its appropriation in time, work would have to stop. Fortunately, Congress usually provided the sums he asked for. By the end of 1881, in addition to the \$200,000 provided in the act of 1876, Congress had passed two appropriations totalling \$300,000. At that time Casey still had \$61,257, which would have taken him as far as June 1882. He estimated that he needed another \$200,000 to continue the work through fiscal 1883.

Although Casey requested \$200,000 at the end of 1881, he received only \$150,000 in the last appropriation. By the end of 1882, he had a balance of \$33,417 after expenditures. When Casey submitted his 1882

report to the commission, he estimated he would need another \$250,000 to finish the shaft, pyramidion, staircase, and elevator.

In 1882 the marble arrived from the quarries in greater quantities than expected, so by the end of November an additional 90 feet of stone was added to the shaft. The obelisk now reached 340 feet. Casey estimated that the walls of the shaft and pyramidion would be completed by mid-1884.<sup>58</sup>

Casey's design called for the proportion of granite backing to the marble facing to diminish as the walls rose. When the obelisk reached 450 feet, the granite backing would stop and the walls from there to the summit would be entirely of marble.

Although 1882 was a relatively good year for the delivery of marble, 1883 was not. Up to that time Hugh Sisson provided all the marble, except for the brief interval of the Massachusetts Marble Company contract. In 1883, however, the selection of the Lee Marble Company of New York led to the loss of three months of work because the company failed to fulfill its contract. As a result, in 1883 the workmen added only 70 feet to the obelisk, making it 410 feet tall.<sup>59</sup>



**The monument nearing completion in 1882, seen from the White House lawn.** *Library of Congress (photograph USZ62-24664).*

By the end of 1883, the stone masons finished dressing the last of the granite backing. Casey revised his earlier estimate. He believed that enough marble was arriving to enable completion of both the walls and pyramidion by the end of the 1884 working season.<sup>60</sup>

In the meantime, Congress appropriated the \$250,000 that Casey had requested the previous year. With the balance of the 1882 appropriation, \$153,375 remained. Casey felt this was sufficient to finish the walls of the shaft, the pyramidion, staircase and platforms, floor, and elevator. This estimate did not include the embellishment of the doors, construction of the terrace or approaches to the monument, insertion of the memorial stones, or installation of a lighting system in the interior of the monument.<sup>61</sup>

On 9 August 1884, the masons set the last piece of marble in place, completing the shaft to 500 feet. Due to the thinness of the walls at this height, the stonemasons took extreme care in setting these stones. Between the 440th and 452nd levels, they freely used galvanized iron clamps. Between the 452nd and 500th-foot levels, they set the walls entirely of marble. Beginning at the 470-foot level, where the ribs of the pyramidion began, mortises and tenons cut in the builds and beds of the marble secured the courses of marble together.<sup>62</sup> Only the construction of the pyramidion remained.

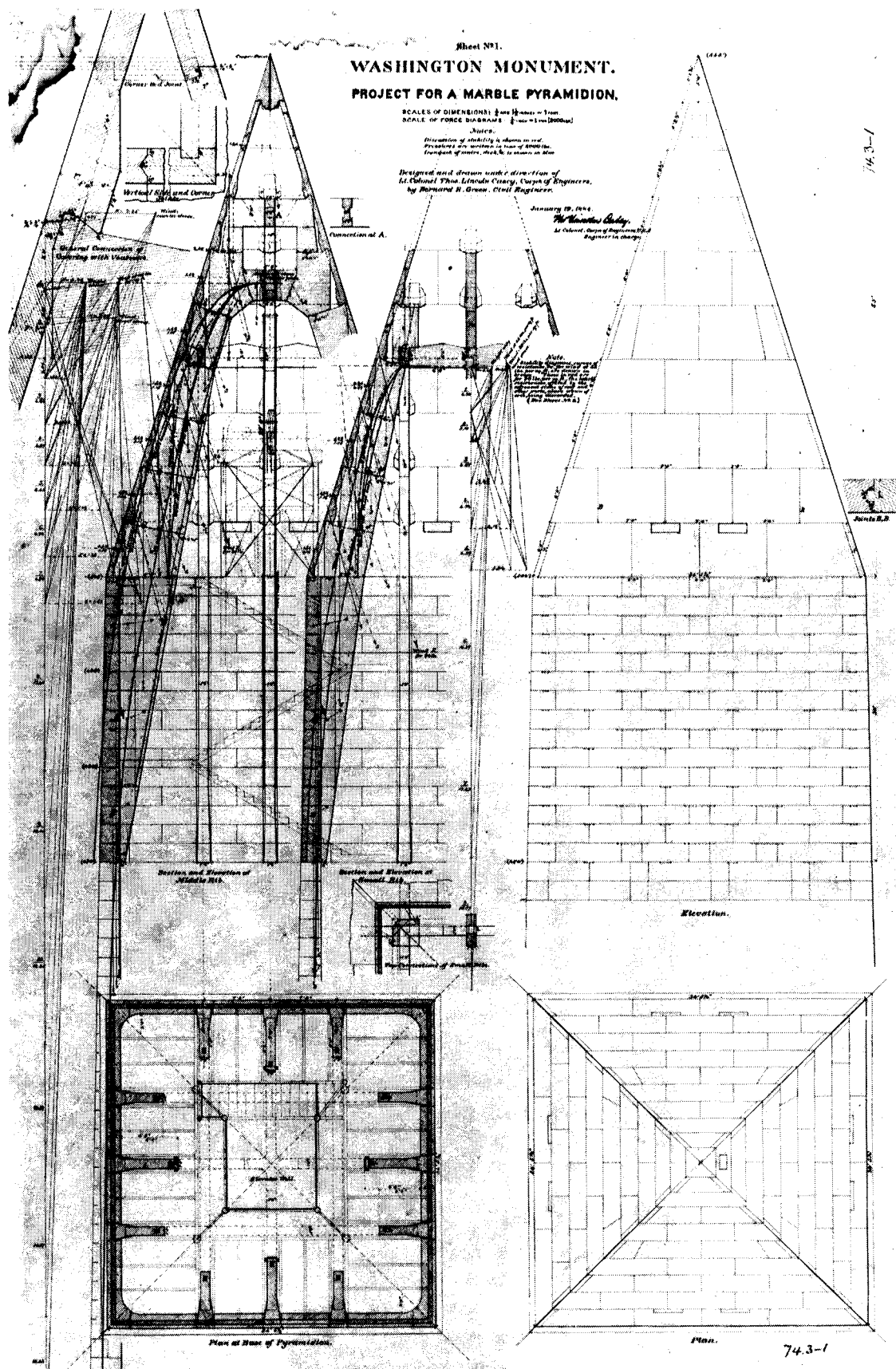
## The Pyramidion

When Casey presented his plan for completing the obelisk to the Joint Commission in 1878, he described a pyramidal roof of metal and hammered glass to provide light for the interior. He had fixed the height of the pyramidion at 25 feet.<sup>63</sup> Since those early years, however, he had strengthened the foundation and modified the shaft. Following the theories of Ambassador Marsh, he heightened the monument to 555 feet and lengthened the pyramidion to 55 feet. The walls of the obelisk became thinner the higher they rose, thereby placing as little weight as possible on the foundation. Weight, therefore, became a significant factor in developing his plans for the obelisk.

As the walls of the shaft neared completion, Casey and civil engineer Bernard Richardson Green, a long-time member of Casey's staff, decided a metal roof would be too heavy for the monument. They also agreed that if metal or some other materials employed on the roof were different from the marble walls, they would probably discolor and ruin the white marble. In short, the roof was to be of the same marble as the walls, cut in slabs that were as large as possible to reduce the number of joints.

Green was born on 28 December 1843, in Malden, Massachusetts. He began his engineering career as a civilian with the Corps of Engineers. For 14 years he worked primarily on the construction of coastal defenses in the northeast. It was on these assignments during the Civil War that he met Casey.

When Casey assumed responsibility for the Office of Public Buildings and Grounds in 1877, he had Green transferred to Washington to work



These detailed diagrams of the pyramidion by Bernard Richardson Green show the exterior and interior of the monument, ironwork of the decks, stairs and elevator and calculations on stability and stress. *National Archives (Record Group 79, file 74.3-1).*

under him. Green distinguished himself as an architectural engineer during the construction of many government buildings. After Casey's assignment to the Washington National Monument, he entrusted Green with the completion of the State, War, and Navy Building. Green introduced new construction methods and because of his efficient management the structure was completed at a much smaller cost than originally estimated.

Green also supervised the construction of the Army Medical Museum and of some of the principal buildings of the Soldiers Home. After Casey resigned as engineer in charge of the monument in 1888, Green worked under him at the new Library of Congress. When Casey died in 1896, Green was appointed in his place. After the Library was completed in 1897, he was made its superintendent, an office he held until his death. During the years he held this position, his interest in the Washington National Monument never ceased. He often gave advice on how best to maintain the monument in a sound condition.<sup>64</sup>

Before 1881 Green's name does not appear often in the monument's official records. However, after Davis left to become aide to General Philip Sheridan, Green assumed a prominent role at the monument.<sup>65</sup>

Some confusion has arisen over whether Casey or Green should receive the credit for designing and executing the pyramidion. The literature and records indicate that both men were equally responsible for the pyramidion. Casey may have assumed a greater role in creating the general plan of the roof by carefully observing the theories set down by Ambassador Marsh. Green said that "It was [under] Colonel Casey's own investigation and direction that the present outline of the pyramidion was adopted, giving to the monument that correctly proportioned crowning feature, without which, as in the original design, the shaft would have been architecturally little better than a chimney."<sup>66</sup>

On the other hand, there is every reason to believe that Green offered his engineering expertise on the detailed complexities of the design and the method of executing it. A detailed plan of the pyramidion is inscribed, "Designed and drawn under direction of Lt. Col. Thos. L. Casey, Corps of Engineers, by Bernard Richardson Green, Civil Engineer."<sup>67</sup> One writer has "ascribed the conception and working out of the plans for placing the pyramidion...on the shaft, plans adopted by the engineer in charge" to Green.<sup>68</sup>

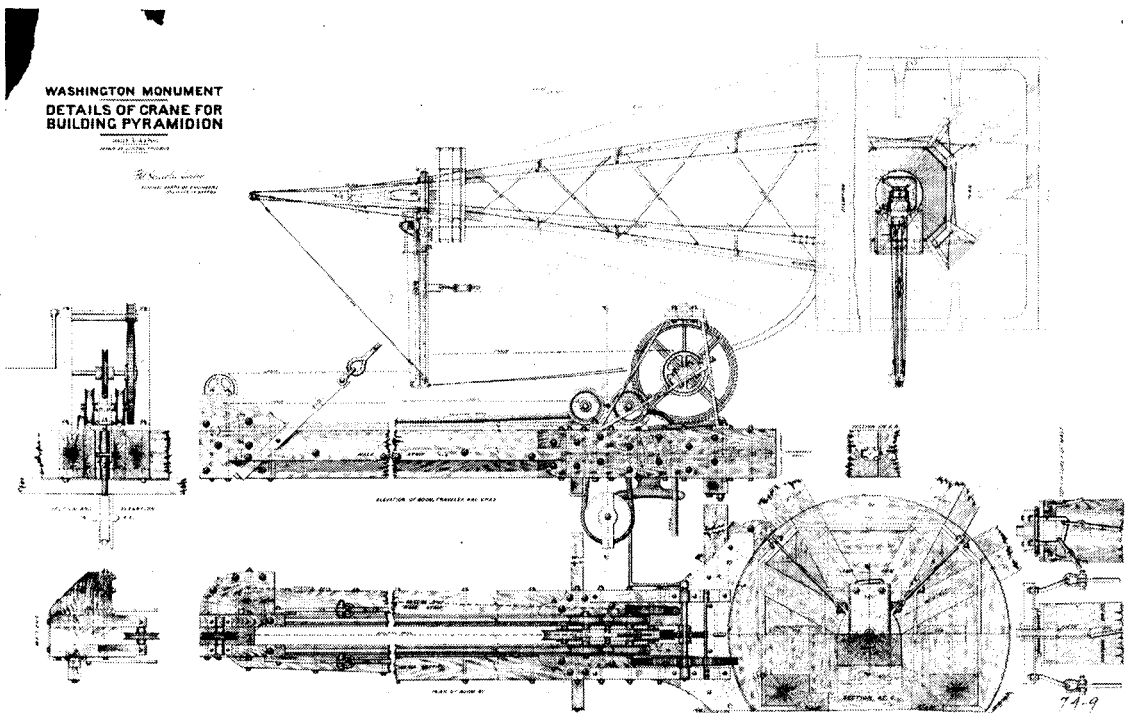
In January 1884 Casey presented his newly developed ideas for the pyramidion to the Building Committee. His plan was unquestionably a radical change from the one originally proposed in 1878, but the Building Committee accepted it. Shortly afterwards the commission gave its approval.<sup>69</sup>

As the walls of the shaft neared completion, Casey's men began the preliminary task of assembling machinery and scaffolding to be used in constructing the roof. By the end of August 1884, the workers had fixed in

place a derrick, mast, and boom to be used in setting the stone for the pyramidion. Men worked as long as 16 hours a day and until 9 p.m. under huge powerful lights that had been placed on nearby buildings.<sup>70</sup>

Work began on the roof in September. The delicate nature of the process of cutting the relatively thin marble slowed the cutters, forcing Casey to lay off some masons until enough dressed marble was on hand. In October, Casey increased the number of cutters to 93, which apparently solved the problem. Of the 262 pieces of marble needed to build the roof, the cutters had dressed all but 64 by the end of the month. This was enough to permit the masons to resume setting the stones. By the end of November, the last pieces of marble were cut and ready to be set.<sup>71</sup>

Although the new plan for the pyramidion made no reference to a metal apex, the capping of the roof with a metal apex was a significant achievement. The new plan had not included one, but Casey and Green tipped the apex with aluminum because its high conductivity would protect the monument from electrical storms. The metal apex was to serve as an integral part of a system of lightning rods. Casey and Green were also pleased because the pure aluminum would not tarnish when exposed to air and thus would not stain the marble.<sup>72</sup>



**Structural diagrams for the crane that would set the stones for the pyramidion.**  
*National Archives (Record Group 79, file 74.15-21).*

To prepare this unusual piece of metal, Casey selected a retired Army colonel living in Philadelphia, William Frishmuth. To help Frishmuth make the tip, Casey sent him a wooden model that acted as a casting mould. When completed, the 100-ounce metal apex was 5.6 inches

on each of its four sides measured at the base and 8.9 inches high. The apex had inscriptions on all four sides. On the north face was the inscription:

Joint Commission

at  
Setting of Capstone.

Chester A. Arthur.  
W.W. Corcoran, Chairman.  
M.E. Bell.  
Edward Clark.  
John Newton.

Act of August 2, 1876.

The west face read:

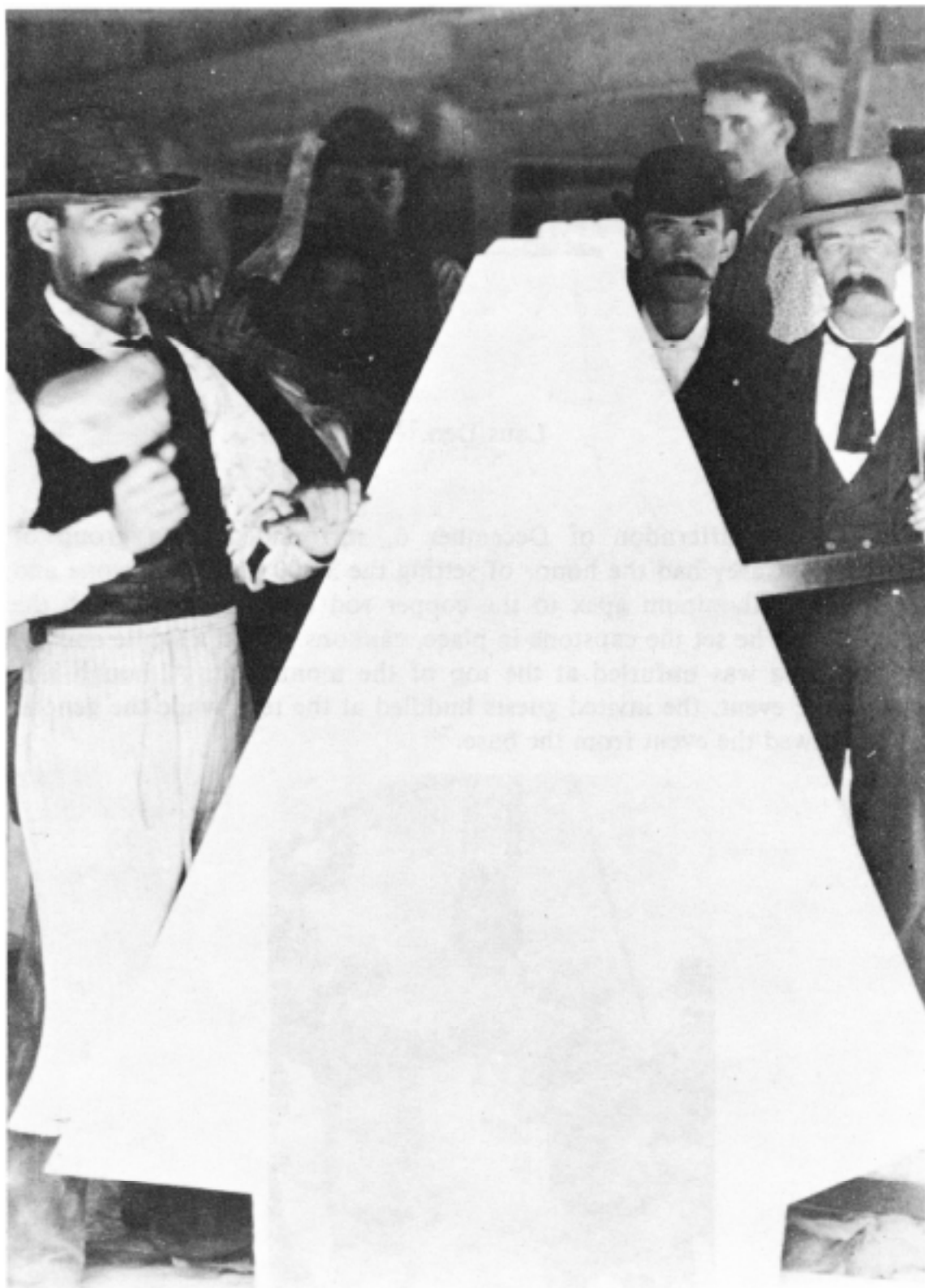
Corner Stone Laid on Bed of Foundation  
July 4, 1848.

First Stone at Height of 152 feet laid  
August 7, 1880.

Capstone set December 6, 1884.

On the south side appeared:

Chief Engineer and Architect,  
Thos. Lincoln Casey,  
Colonel, Corps of Engineers.



**Workmen finishing the capstone.** *Library of Congress (photograph USZ62-24663).*

Assistants:  
George W. Davis,  
Captain, 14th Infantry.  
Bernard R. Green,  
Civil Engineer.  
Master Mechanic,  
P.H. McLaughlin.

The east side intoned:

Laus Deo.<sup>73</sup>

On the afternoon of December 6, surrounded by a group of dignitaries, Casey had the honor of setting the 3,300 pound capstone and securing the aluminum apex to the copper rod that passed through the capstone. As he set the capstone in place, cannons roared a salute and the national flag was unfurled at the top of the monument. Although rain marred the event, the invited guests huddled at the top, while the general public viewed the event from the base.<sup>74</sup>



**Master mechanic and chief supervisor P. H. McLaughlin readies the aluminum apex for setting by Thomas L. Casey. From a sketch made during the dedication for *Harper's Week/y* by S. H. Nealy. Library of Congress.**

Only one task remained before the roof was finished. The plan called for nine small openings. Eight were to be windows. The ninth opening located just beneath the apex would allow the masons to exit onto wooden platforms to complete their work on the exterior.

While the walls of the shaft were rising, they were nearly perpendicular. A large opening of the well in the center afforded access to the exterior. However, because the side of the pyramidion gradually converged until there was little or no opening, Casey and Green had to devise a series of scaffolds at different levels. The masons and other workers could then exit from the nine openings at the top onto the different scaffolds. Wood ladders connected the scaffolds. When the pyramidion was finished, the uppermost scaffold was removed first, and as the men descended, they removed the lower scaffolds, finally reentering the monument through the openings.<sup>75</sup>

The eight windows would be placed in pairs near the base of each face of the pyramidion for visitors. Following Marsh's advice Casey placed marble shutters on these openings so they would blend into the obelisk. To make the shutters functional, Casey encased the marble slabs in bronze frames. He made the frames, hung upon revolving cranes, of a "statuary bronze" that was resistant to corrosion and would not stain the marble. Each of the four pairs of frames was built so that one shutter could open to the right while the other could open to the left. Three pairs of openings were each three feet wide by 18 inches high, while the fourth pair was three feet wide by 24 inches high. Each shutter had a padlock and bolt made of bronze, so the windows could be locked. "When the windows are closed by these shutters," said Casey, "the pyramidion is much improved in appearance, and the interior of [the] shaft is protected from storm waters, which would otherwise flow into them from the roof and flood the upper platforms."<sup>76</sup>

The contractor delivered the bronze frames in late January 1885, but the shutters were not installed until March. The pyramidion was now complete.

The pyramidion was built of marble slabs no more than seven inches thick. Each slab rested upon the projections of 12 marble ribs that were laid vertically. Although these ribs, three on each side of the shaft, sprang from the 470-foot level, they eventually converged at the top of the pyramidion. The pyramidion weighed 300 tons. In addition to the ribs, it consisted of 262 slabs of marble measuring 3,764 cubic feet. The capstone cuneiform keystone measured 5.16 feet from its base to the top. Each side of the base was three feet long. The aluminum tip fitted snugly at the top.<sup>77</sup>

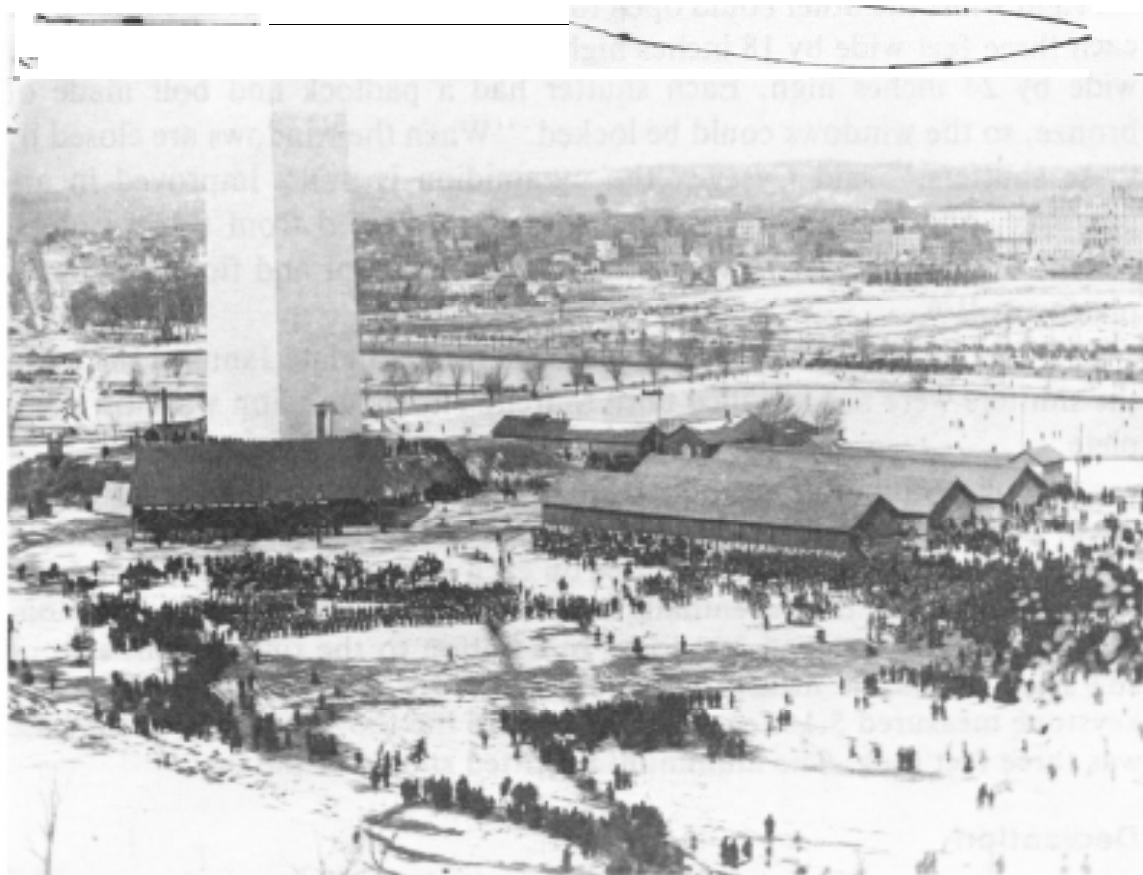
## Dedication

Long before the workmen finished the pyramidion and the monument was ready to receive its first visitors, the Society began preparations

for the long-awaited dedication. After Casey reported that the superstructure would probably be completed in early 1885, the Society requested that Congress authorize the dedication of the monument so that adequate preparations could be made well in advance. The Society based preparations on Casey's estimates of work yet to be done. His estimates were optimistic but reasonable. Only serious inclement weather and an inadequate supply of marble could cause any error in his calculations. The Joint Commission agreed with the Society's request and notified Congress.<sup>78</sup>

On 13 May 1884, by a joint resolution, Congress created a special commission of five senators, eight representatives, and three members of the Society, to arrange for the dedication. As plans for the occasion progressed, Casey proceeded with his own arrangements. He ordered workers to remove the huge quantity of materials and temporary facilities that had accumulated on the grounds. They removed the blacksmith shop, scaffolding carrying the railroad track into the monument, and the derricks. Other temporary buildings were later destroyed as construction on the superstructure gradually diminished.<sup>79</sup>

The dedication was held on 21 February 1885, the day before Washington's birthday. No amount of formality and jubilation was spared. Ben Perley Poore, a witness to the event, recalled that the day of dedication was clear and cold. Snow covered the ground around the base of the shaft. A



**The dedication ceremony, 21 February 1885.** *Library of Congress (photograph USZ62-19647).*

keen wind that blew down the Potomac “made it rather uncomfortable.” All of official and private Washington seems to have attended:

The regular troops and the citizen soldiery were massed in close columns around the base of the monument, the Freemasons occupied their allotted position, and in the pavilion which had been erected were the invited guests, the executive, legislative, and judicial officers; officers of the army, the navy, the marine corps, and the volunteers; the Diplomatic Corps, eminent divines, jurists, scientists, and journalists, and venerable citizens representing former generations, the Washington National Monument Society, and a few ladies who had braved the Arctic weather.

President Arthur concluded the ceremony by declaring the monument dedicated from that time forth “to the immortal name and memory of George Washington.” That evening fireworks lit up the Mall.<sup>80</sup>

Senator Sherman, W.W. Corcoran, and Casey all spoke. In his address, Casey simply described the monument he had helped complete. He emphasized the strength of the foundation--his major achievement--and the beauty and resistance of the shaft.

**Chester A. Arthur.**  
*Library of Congress.*

